

Space Weather Technical Forecast

Issued on Sunday, 19 May 2024 at 12:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of isolated M-class flares throughout. Chance of G1-G2 (Minor/Moderate) Storm conditions day 2 and 3 (20 and 21 May).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was at Low levels, with the largest flare a C4.1 event at 18/1938 UTC from AR3685. There are currently nine sunspots on the visible disc, with the re-emergence of AR3684 in the southeast and development of AR3687 in the northeast. AR3685 (Ehi/Beta-Gamma) in the southeast remains the largest group on the disc, with slight growth and consolidation in its intermediate spots. AR3679 (Esi/Beta-Gamma) located near centre-disc in the southern hemisphere remained largely unchanged. AR3683 (Dai/Beta) in the southwest indicated weak development, with some growth and consolidation of its intermediate spots. The other sunspot regions are generally smaller, simpler and more stable.

A large filament liftoff from the southern hemisphere that began around 18/2200UTC has been modelled as missing below Earth orbit. Therefore no Earth-directed CMEs were observed in coronagraph imagery.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 were indicative of a near background regime, though perhaps with minor positive coronal hole influence at the end of the period. Speeds generally declined from 400-450km/s to around 360-380km/s by early 19 May, before a late increase to around 410-430km/s. The density of the solar wind was predominantly below average, though briefly reached above average levels of 11ppcc at 19/0929 UTC. The Interplanetary Magnetic Field (IMF), Bt, was largely weak, but increased to occasionally moderate levels from 19/0326 UTC, peaking at 9nT at 19/1042 UTC. The north-south component Bz was predominantly weakly negative, but briefly reached moderately negative values at 19/1100 UTC. Bz varied between +2/-8nT. Phi angle was positive (away from the Sun) throughout. Geomagnetic activity was at Quiet to Unsettled levels (Kp0-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10 MeV) remained below the S1/Minor Radiation Storm levels, but above normal background levels, on a slow decline. High energy electron flux (greater than 2MeV) observed by GOES-16 was at background to moderate levels. The associated 24-hour fluence has remained below the Active threshold. Observed fluence at 19/0000 UTC of 2.91e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with a chance of isolated M-class flares and a very slight chance of isolated X-class flares. AR3685 is most likely to be the source of significant flare activity.

Solar Wind / Geomagnetic Activity: There is a very unlikely, but slight chance of a glancing impact from a CME on day 1 (19 May). A more notable CME arrival may glance Earth late day 2 (20 May) or perhaps early day 3 (21 May), resulting from the M7.2 flare of AR3685 that occurred late on 17 May.

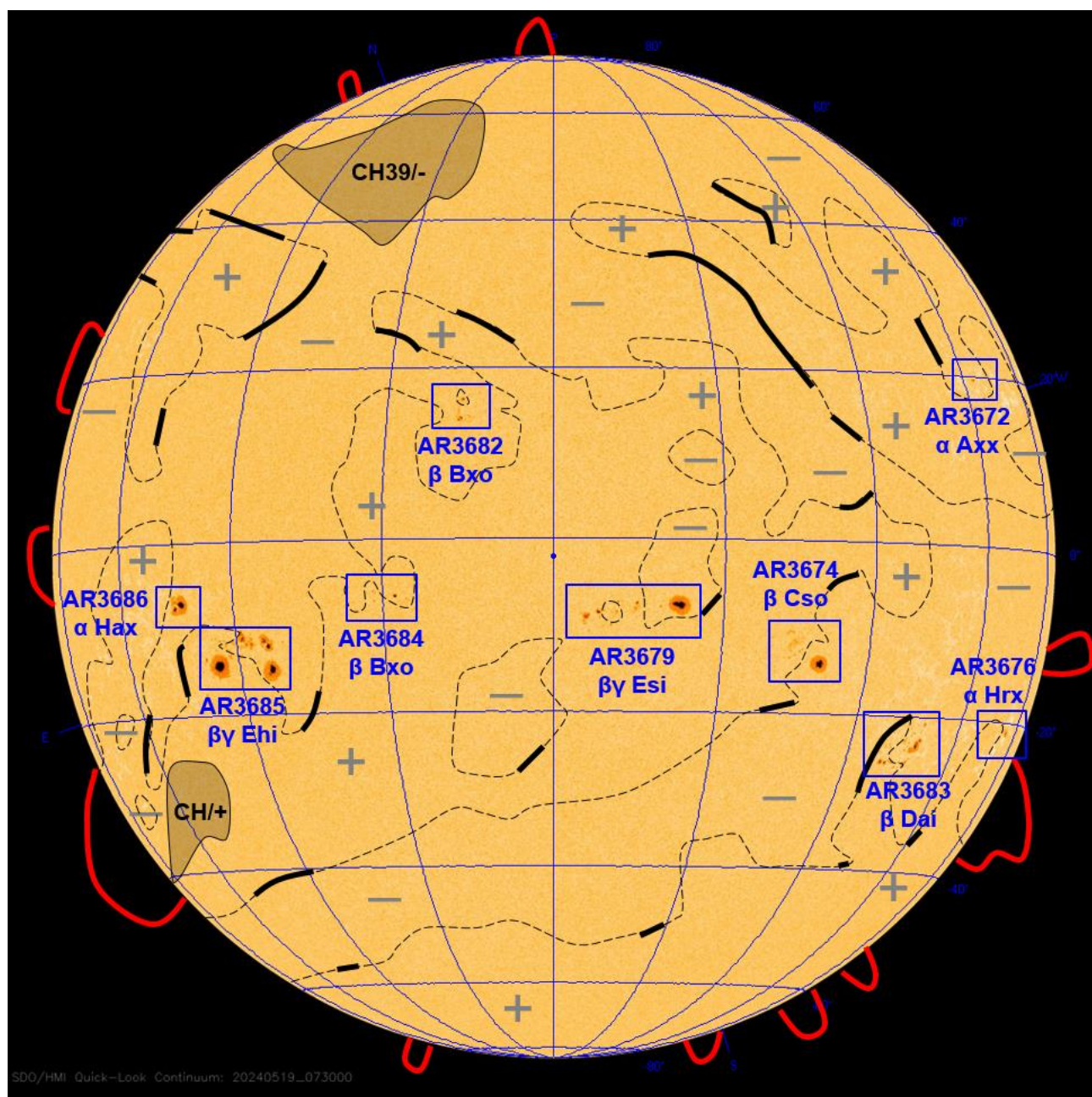
In the absence of any CME arrivals, solar winds are forecast to remain at or near background speeds throughout the period with no significant coronal hole enhancements expected.

Generally Quiet conditions are expected through the early period, but with a very slight chance of Active to G1/Minor Storm conditions on day 1 (19 May) subject to the unlikely potential for a CME arrival. A more significant glancing CME blow is possible late day 2 (20 May) or early day 3 (21 May) with a chance of G1-G2/Minor-Moderate (Kp5-6) intervals and a slight chance of G3/Strong (Kp7) intervals should we see a more significant impact. Activity should then subside towards Quiet to Unsettled levels again by the end of day 4 (22 May).

Energetic Particles / Solar Radiation: Proton flux is below the S1/Minor Storm threshold, on a slightly declining trend, but remains just above normal background levels following flare activity from the past week. There is a persistent slight chance of further enhancements should any large flares occur.

High energy electron flux is at background to moderate levels. However there is the potential for electron flux to rise and potentially reach high levels into the period. Any rise in electron flux is expected to be curtailed by further CME influence, most likely occurring late day 2 (20 May) or early day 3 (21 May). The associated 24 hour fluence is expected to follow a generally rising trend through the period with a slight chance to reach the Active threshold by days 3 and 4 (21-22 May), though dependent on the extent of any CME enhancement.

Figure 1. Solar Analysis Valid 19/0700 UTC.



Key: Filament --- , Prominence --- , Magnetic Field Line --- , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

Two potentially Earth-directed CMEs currently feature in the forecast period. A filament eruption from the northeast disc around 15/1000 UTC resulted in a CME that has been modelled to pass north of Earth's orbit on day 1 (19 May). Although considered very unlikely, there is a slight chance of a glancing impact from this CME. Late on 17 May a complex 'double-structured' moderately-fast CME was seen in coronagraph imagery associated with the M7.2 flare of AR3685 in the southeast disc. Type II and IV Radio Emissions as well as a distinct EUV wave signature were observed. Modelling of this feature suggests the potential for a glancing impact late day 2 (20 May) or perhaps early day 3 (21 May).

In the absence of any CME arrivals, solar winds are forecast to remain at or close to background speeds, with no significant coronal hole enhancements expected.

Generally Quiet conditions are expected through the early period, but with a very slight chance of Active to G1/Minor Storm conditions on day 1 (19 May) subject to the unlikely potential for a CME arrival. A more significant glancing CME blow is possible late day 2 (20 May) or early day 3 (21 May) with a chance of G1-G2/Minor-Moderate (Kp5-6) intervals and a slight chance of G3/Strong (Kp7) intervals should we see a more significant impact. Activity should then subside towards Quiet to Unsettled levels again by the end of day 4 (22 May).

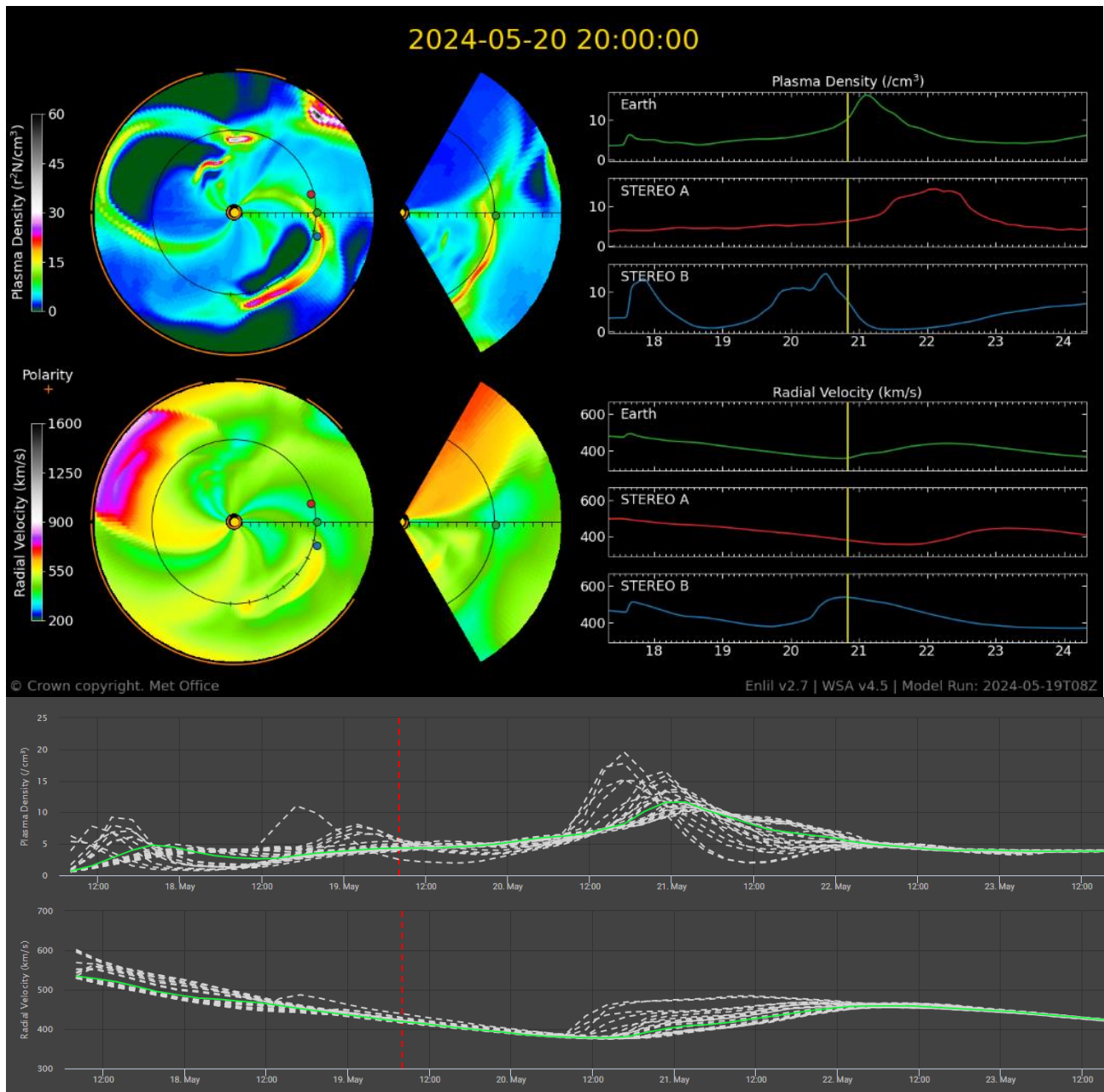
Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	5	50	50	5
Strong	G3	No	1	10	10	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
15/1632	Partial	Filament	NE	630 km/s	19/0000 UTC +/- 7 hours	Slight chance of glancing impacts
18/0039	Partial	AR3685	SE	950 km/s	20/2000 UTC +/-10 hours	Chance of glancing impacts



Figure 2: Latest MOSWOC Enlil output and Ensemble, showing M7.2 flare CME passing mostly behind and below Earth orbit, but with some glancing influence.



Radio Blackouts - X-Ray Flares:

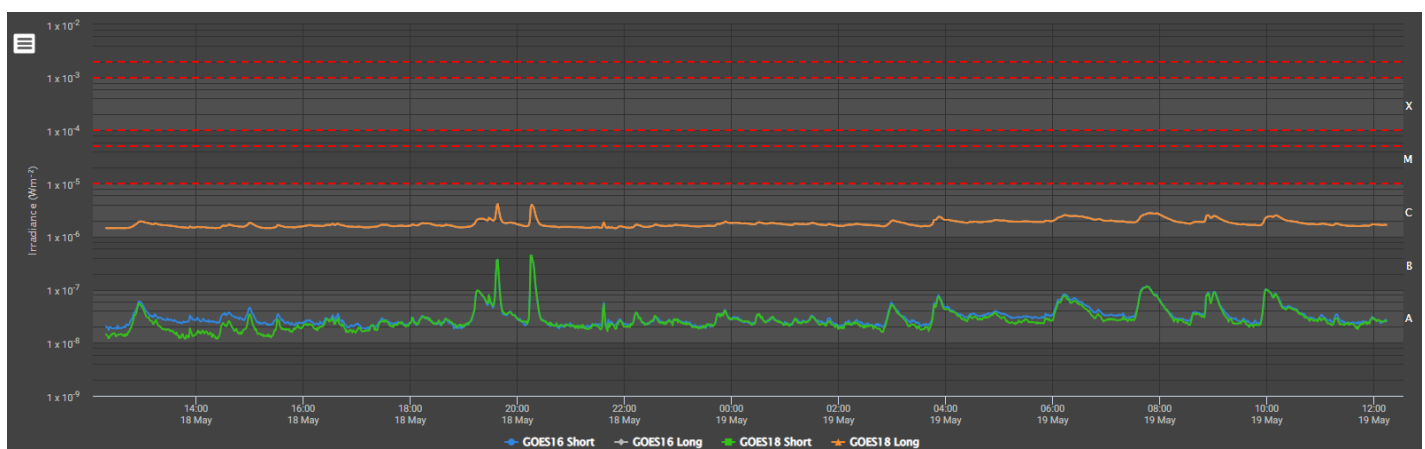
There are nine sunspot regions on the visible disc. AR3685 (Ehi/Beta-Gamma) in the southeast is considered to be the most likely source for significant flare activity, having previously produced X2.9 and M7.2 flares on 15 May and 17 May respectively. The region is composed of a number of large, mature spots with several smaller spots of mixed polarity present. These smaller spots appear to be consolidating and there are indications of a weak delta spot developing. AR3679 (Esi/Beta-Gamma) near centre-disc in the southern hemisphere is the next largest region and has been the source of some low-level C-class activity. Although the main lead and trailer regions are well-separated there are a number of small pores or spots of mixed polarity occupying the intermediate portion of the group. AR3683 (Dai/Beta) in the southwest indicates modest magnetic complexity with numerous small spots and continued slight development and consolidation. The other sunspot regions are generally smaller, simpler and generally stable.

No significant returning regions are expected through the period or strongly signalled in far-side sounding data, with all the current notable flare producing regions remaining on the visible disc though the next four days. As such, the current flare risks have been maintained through the period pending further developments.

Low to Moderate activity is expected with a chance of isolated M-class flares and a very slight chance of isolated X-class flares. AR3685 is most likely to be the source of significant flare activity.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: Latest GOES16/18 X-ray flux



Solar Radiation Storms - (High Energy Protons):

Proton flux is below the S1/Minor Storm threshold, on a slightly declining trend, but remains just above normal background levels following flare activity from the past week. There is a persistent slight chance of further enhancements should any large flares occur, especially given the number of sunspot regions on the Earth-facing disc. AR3685, the largest and most actively flaring region on the disc will, however, remain in a generally unfavourable position (in the eastern hemisphere) for significant proton enhancement throughout.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	10	10	10	10
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)

High Energy Electrons Event ($\geq 2 \text{ MeV}$):

High energy electron flux, as observed by GOES-16 is at background to moderate levels. However there is the potential for electron flux to rise and potentially reach high levels into the period, with lower orbits having been highly charged by numerous strong CME arrivals in the past week to ten days. Any rise in electron flux may be curtailed by further CME influence however, this considered most likely late day 2 (20 May) or early day 3 (21 May).

The associated 24 hour fluence is expected to follow a generally rising trend through the period with a slight chance to reach the Active threshold by days 3 and 4 (21-22 May), though dependent on the extent of any CME enhancement. In the absence of CME enhancements MOSWOC REFM looks to be providing reasonable guidance, although perhaps slightly under representing the risk of reaching the Active threshold later in the period.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	5	10	20
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1



Figure 4: GOES16 >2MeV Electron Flux (above) and MOSWOC REFM forecast with Recurrence (below)

